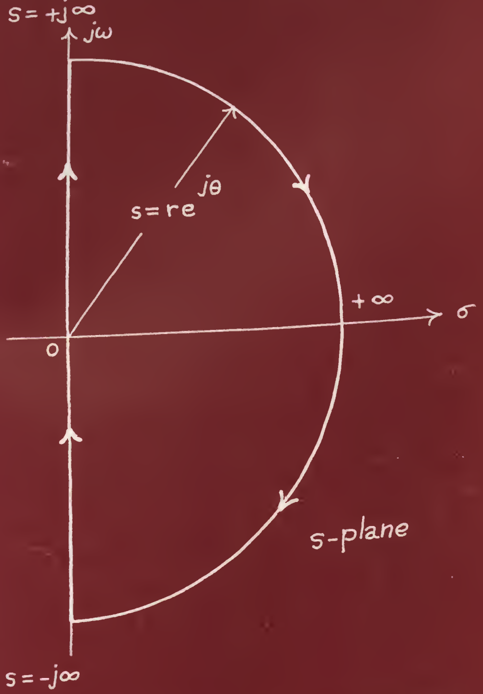
Mechelectiv

VOL. 20 MAY, 1962 NO. 6



THE GEORGE WASHINGTON UNIVERSITY

MAY 1962

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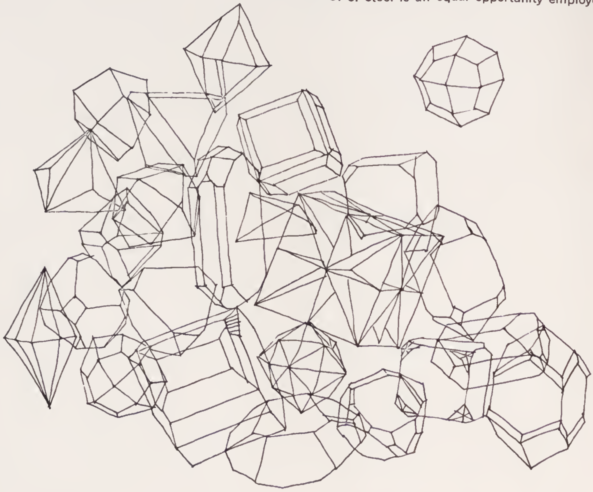

United States Steel USS

TRADEMARK

I chose a career,

not a job!

by Pete Vossos

"I found a satisfying job right from the beginning—and more important, American Oil is diversified enough to offer varied opportunities for the future."

Peter Vossos earned his Master of Science degree at Iowa State, '58. As a physical chemist, Pete's immediate project is studying fundamental properties of asphalts with the objective of improving their performance in roofing and industrial applications. About his 2½ years at American Oil, Pete adds, "This is a company that's big enough and dynamic enough to be doing important work, but not so mammoth that you get lost in the crowd."

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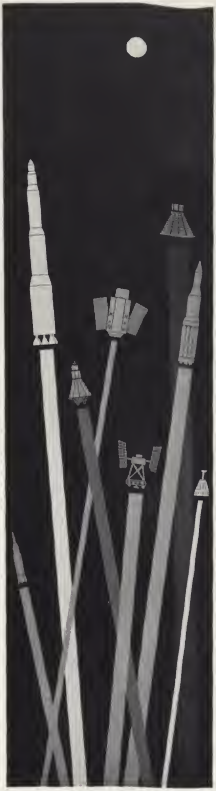

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ARTICLES

FEATURES

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SAMPLED-DATA CONTROL SYSTEMS

by Fabio A. Convers

One of the most important aspects of Electrical Engineering is that which deals with the application of signals to a network in order to get a desired response, to store a particular information, or to compute a required value.

Systems in which signals are applied at equally spaced intervals of time at one or more points are called sampled-data control systems. No information is received between two consecutive signals. This definition can be extended to systems called "aperiodic sampled-data control systems", in which signals are applied at random intervals of time.

The features of sampled-data systems play an important role in the field of automatic control and communication systems. Their application can be divided into two main categories. The first category involves those systems in which information is available only in samples. The second category involves those systems in which the sampling information although available at all times, is purposefully introduced. Examples are (1) the error sampling system can be made extremely sensitive by not requiring it to drive a load constantly, (2) the error computing system can be time-shared among several control problems, (3) in the field of process control, economical use of measuring devices of temperature, pressure and flow can be realized and (4) savings can result in telemetering and other communication systems.

The sampler is an essential component in the block diagram of any sampled-data system. It converts a continuous signal to a train of regularly spaced, amplitude modulated, narrow pulses.

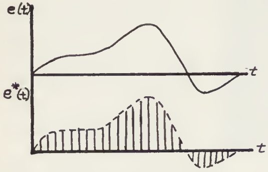


Figure 1

Figure 1 illustrates the function of the sampler. If the duration of the sampler pulses is small in comparison with the time constants of the system of which the sampler is a part, the sampled output e*(t) can be considered as a sequence of impulses occurring at the sampling instances O, T, 2T . . .; the strengths of the individual impulses being equal to the values of the input function e(t) at the respective constants.

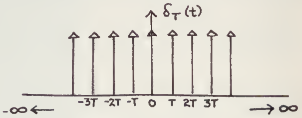


Figure 2

$$e^*(t) = e(t)\,\delta_T(t) \quad (A)$$

Where * is used to indicate that e*(t) is a discreet, sampled function, and δ(t) represents a periodic train of unit impulses spaced T seconds apart.

$$\delta_T(t) = \sum_{n=-\infty}^{\infty} \propto (t-nT)$$

if in (A) e(t) = o for t < o then

$$e^*(t) = \sum_{n=o}^{\infty} e(nt)\,\delta(t-nT)$$

The Laplace transform of the sampled output function e*(t), is

$$E^*(S) = \mathcal{L}\{e^*(t)\} = \mathcal{L}\Big[\sum_{n=o}^{\infty} e(nT)\,\delta(t-nT)\Big] \quad (B)$$
$$= \sum_{n=o}^{\infty} e(nT)\,e^{-nTS}$$

Calling $z = e^{TS}$, we obtain from (B)

$$(B') = E(Z) = \sum_{n=o}^{\infty} e(nT)\,z^{-n} = Z[e^*(t)]$$

Equation (B') defines that Z transform F (z), of the sampled function e*(t). F(z) is seen to be an infinite series in powers of z^{-1}. If F(z) is given in the form of a ratio of two polynomials in z or z^{-1}, all we have to do to find its inverse transform is to expand it in a series in powers of z-1 by long division; the co-efficients in the series will then correspond to the values of e*(t) at the sampling instants. Let me illustrate this with an example.

find $Z^{-1}\left[\frac{TZ}{(Z-1)2}\right]$

$$\frac{TZ}{(Z-1)2} = T\,\frac{Z^{-1}}{(1-Z^{-1})2} = T\,\frac{Z^{-1}}{1-2Z^{-1}+Z^{-2}}$$

$$= T(Z^{-1} + 2Z^{-2} + 3Z^{-3} + \ldots + KZ^{-k}$$

$$= \sum_{n=o}^{\infty} (nT)\,Z^{-n}$$

Hence $e^*(t) = Z^{-1}\left[\frac{TZ}{(Z-1)2}\right] = \sum_{n=o}^{\infty} (nT)\,\delta(t-nT)$

Now that the Z transform in connection with the sampled-data system has been introduced, let me go back briefly to illustrate one of the many applications of these systems.

In this system, with the aid of a sampler (commutator) which samples the error point voltage of each amplifier in turn, one stabilization amplifier is used to stabilize a group of d-c amplifiers. If any voltage is present at the error point of a particular amplifier, it is applied to the stabilization amplifier as a series of pulses occurring at the repetition rate of the commutator. These pulses are amplified and inverted in the stabilization amplifier, demodulated at the output section of the commutator, and applied to the same amplifier through a smoothing filter. Thus one stabilization amplifier can be time-shared by several d-c amplifiers, a feature which reduces the cost, size, and maintenance of equipment.

It is evident from the definition of sampled-data systems that the information received by the system is discreet and is admitted at equal intervals of time. The sampler periodically samples the continuous information and delivers a set of pulses to the system.

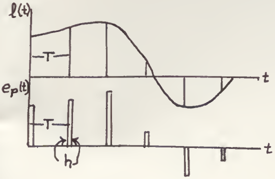


Figure 3

But if the time closure of the system (information duration), h, is very small compared to the dominant time constant of the system, we can replace the set of finite pulses of the sampler output by impulses of areas equal to the corresponding input function.

For the analysis the following assumptions are made.

1. The sampler is ideal (can break and make contact easily).
2. The pulse duration h is very small compared to the dominant linear system time constants.
3. The sampler operation is periodic.
4. The sampled information is fed to a linear relaxed system.

As has been shown before, the basic equation which describes the sampler output (Figure 1) is $e^*(t) = e(t) \times \delta_T(t)$ where $\delta_T(t)$ represents a series of unit impulses (area equal to unity) equally spaced in time and extends from minus infinity to plus infinity, and represented in the following expression.

(B'') $$\delta_T(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT)$$

Equation (B'') can be visualized as amplitude modulation of the unit impulses by the input signal. Since e(t) is described for positive values of time, only the theory of real multiplication can be applied to find the Laplace transform of $e^*(t)$.

$$\mathcal{L}\{e^*(t)\} = \mathcal{L}\{e(t) \times \delta_T(t)\} = \frac{1}{2\pi j}\int_{C-J\infty}^{C+J\infty} E(p)\, \frac{1}{1-e^{-T(S-P)}}\, dp$$

where $E(S) = \mathcal{L}\{e(t)\}$

and $\mathcal{L}\{\delta_T(t)\} = 1 + e^{-TS} + e^{-2ST} + \ldots = \dfrac{1}{1-e^{-TS}}$

for $|e^{TS}| < 1$

In the complex P-plane, the contour of integration of equation is along a path $c - j\infty$ to $c + \infty$, which satisfies the following conditions:

$\sigma 92 < C < \sigma - \sigma 91$

$\max(\sigma 91 + \sigma 92) < \sigma$

where C = real part of P
σ = real part of S
$\sigma 91$ = abcissa of absolute convergence of $\delta_T(t)$
$\sigma 92$ = abcissa of absolute convergence of e(t)

The path of integration is restricted by these conditions to an analytic strip which does not enclose or pass through the poles of the integrand in equation (D) as shown in Figure 4.

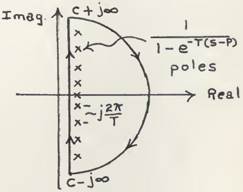


Figure 4

This integral as it stands is hard to solve, but if in the integration we follow the contour of Figure 4, equation (D) can be changed into equation (F).

$$\mathcal{L}\{e^*(+)\} = E^*(s) = \frac{1}{2\pi j}\int E(p)\, \frac{1}{1-e^{-T(S-P)}}\, dp \quad (F)$$

Now we can apply Cauchy's integral formula which says, F = -(Sum of the residues of the integrand at the poles enclosed).

The poles of the integrand in the right-half plane are the zeros of the following function:

$$1 - E^{-T(S-P)} = 0$$

$$\therefore\ -T(S-P) = 2\pi kj \qquad -\infty < k < \infty$$

k = Integer

$$\text{or } P = S + \frac{2\pi kj}{T}$$

$$\text{Thus } E^*(S) = \sum_{k=-\infty}^{\infty} \left. \frac{E(P)}{\frac{d}{dp}\left[1 - e^{-T(S-P)}\right]} \right|_{p = S + \frac{2\pi kj}{T}}$$

—Continued on Page 8

LOUIS SLOTIN

by Stephen Rich

There are so many important people connected with the development of atomic energy that a great many of them are little known by the public. One of these people is Dr. Louis Slotin, who gave his life so that others might live.

Louis Slotin was born in Winnipeg, Canada in 1912. When he was 15, he entered the University of Manitoba, where he got his B.S. in geology in 1932 and his M.S. in 1933. In 1936, he got his Ph.D. in physical chemistry at the University of London. Though quiet and unassuming, Slotin craved adventure. He was visiting a friend in Barcelona when the Spanish civil war broke out; he operated an anti-aircraft gun for the Loyalists. Later, he served with the R.A.F., until they discovered that he wore glasses.

In 1937 on his way home to Winnipeg, he met Prof. William D. Harkins of the University of Chicago. Prof. Harkins, one of the pioneers in atomic chemistry, was in need of an assistant to help build the school's first cyclotron. Slotin took the job without a salary which was not unusual for a physicist in the '30's and did not receive a salary for almost two years. "This (job) served as his introduction to nuclear physics."

In 1942, Slotin began work for the Manhattan District's Metallurgical Laboratory. Later, he went to Oak Ridge to help build the first power producing pile. In December 1944 when the problems of plutonium production were solved and the job of building the bomb begun, he went to Los Alamos. It was Slotin who was responsible for the assembly and the delivery of the first atomic bomb to the Army for the "Trinity" desert test. The receipt which he got for delivering the bomb represented two billion dollars of effort and became his most prized possession. Always adventurous, he wanted very much to go to Hiroshima and Nagasaki as a scientific observer, but since he was still a Canadian citizen a legal delay kept him at Los Alamos. He was scheduled to go to Japan for a third bomb.

It was at Los Alamos that Dr. Slotin began performing the experiment to determine critical mass. A critical mass is the amount of fissionable material that will start and retain a chain reaction. This knowledge was vital to the study of atomic energy and the making of the atomic bomb. The experiment was performed by bringing two pieces of fissionable material near enough to each other and in such a position to each other that they became critical; this point is determined by the intensity of the radiation. This is the same way an atomic bomb works; however, if anything should go wrong there would be no danger of blowing up Los Alamos, since the masses would blow themselves apart first. In an atomic bomb they must be held together. Still it was a risky experiment since radiation is dangerous. Slotin, who performed the experiment at least forty times, called it "tickling the dragon's tail." He well knew the danger of the experiment since one of his co-workers, Harry Daghlian, died in September, 1945 from exposure to radiation in an accident. Slotin stayed by Daghlian's side during the weeks Daghlian was hospitalized.

Dr. Slotin, eager to return to peacetime work, accepted an assistant professorship at the University of Chicago's Institute of Radiobiology. He planned to take the position after his return from the atomic tests at Bikini. On May 21, 1946, he was showing his replacement, Dr. Alvin C. Graves, the technique of critical mass assembly when the fatal accident occured. Dr. Graves, who had never seen the experiment before, and six other scientists stood around a metal desk in the center of an almost empty room on which lay the heart of the atom bomb, and watched as Dr. Slotin maneuvered the two hollow, silvery-gray hemispheres of plutonium closer together with an ordinary screw driver. All listened intently to the rapid click of the geiger counter; some glanced at the rising red line of the neutron monitor, which records the radiation intensity and the time. The experiment was near its critical point; it was just a matter of moving one last piece of metal an eighth of an inch from the rest of the assembly. This piece slipped and closed the gap between the other pieces of metal, greatly increasing the intensity of the radiation. The geiger counter clicked wildly; the neutron monitor went off the scale at exactly 3:20, and a bluish glow came from the metal. Slotin acted instantaneously, ripping the masses apart with his bare hands, thereby stopping the radiation. All eight quickly left the room. Some felt a dry, prickly, sour sensation on their tongues, a sign of excessive radiation; this is the only immediate effect that can be felt. Slotin at once drew a chart of the lab showing where each person was at the time of the accident; this chart helped show how exposed each scientist was. Within an hour all were taken to the Los Alamos hospital.

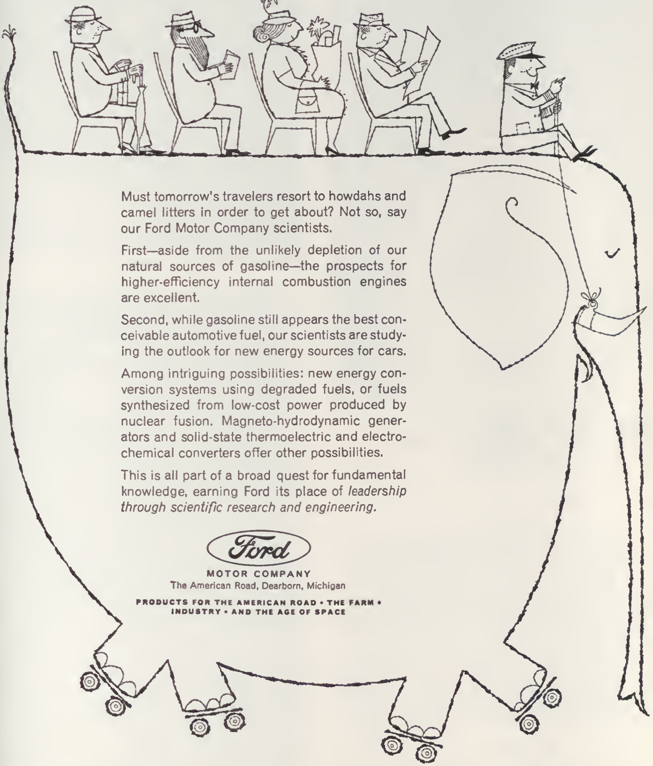
At the time of the accident our knowledge of radiation injuries was quite limited. Radiation kills in a manner opposite to that of cancer; it stops the cells from reproducing. The amount of radiation is measured in roentgens or r's. The amount of radiation which causes a 50 per cent average death rate is called "median lethal dose" or LD/50. At the time it was thought to be about 400r's; now it is thought to be higher. The number of r's received depends upon the power of the source, the time of exposure, and the distance from the source. Slotin received 880r's.

The early effects Slotin showed were nausea and a slight temperature. His hands and arms became so swollen and blistered that they were packed in ice; his abdomen also became tender.

Word of the accident spread quickly through the Manhattan District. Major General Leslie R. Groves, head of the project, wrote Slotin, "I have

—Continued on page 8

what happens if we run out of gas?



Must tomorrow's travelers resort to howdahs and camel litters in order to get about? Not so, say our Ford Motor Company scientists.

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SAMPLED-DATA CONTROL SYSTEMS—Continued from Page 4

Since equation (G) is of infinite series form, this indicates that the sampler produces high frequency components.

Since $\frac{d}{dp}\left[1 - e^{-T(S-P)}\right]_{p=S+\frac{2\pi d}{k}} = -Tej2\pi k$

then $E^*(s) = \frac{1}{T}\sum_{k=-\infty}^{\infty} E\left(S + j\frac{2\pi k}{T}\right)$

but $\frac{2\pi}{T} = W_r$ = Sampling frequency

Hence,

$$E^*(S) = \frac{1}{T}\sum_{k=-\infty}^{\infty} E(S + jkW_r) \quad \text{(G)}$$

Assuming that the input signal has a frequency spectrum as shown in Figure 5; then, the sampler output contains the frequency spectrum of the input plus other frequencies as shown in Figure 6.

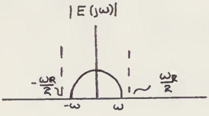


Figure 5

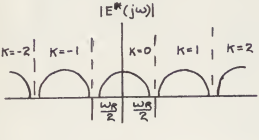


Figure 6

This case illustrates the sampler output when the highest frequency component of the input is less than half the sampling frequency, that is

$$w = wr/z$$

This choice of frequency helps us to recover the input signal without any distortion as is shown in Figure 6.

As shown in Figures 7 and 8, the sampler output signal is a distorted picture of its input signal if the sampling frequency is less than twice the highest frequency of the input.

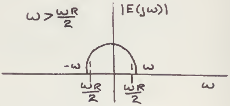


Figure 7

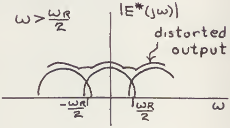


Figure 8

In conclusion we can say that the sampled-data systems must have a sampling frequency larger than or equal to twice the highest frequency component of the input signal, if they are to recover their input signals.

LOUIS SLOTIN—Continued from Page 6

nothing but admiration for your heroic action. . . Your quick reactions and disregard for the danger to yourself undoubtedly prevented a much more serious accident." General Groves also ordered a special army plane to get Slotin's parents.

Five days after the accident Slotin showed bad signs; his tongue became sore from a radioactive filling, his blood count dropped, and his pulse quickened; he could eat nothing and visibly lost weight. On the seventh day, he sank into a coma, and on the morning of the ninth day, May 30, 1946, he died. The seven others recovered.

Louis Slotin was the first peacetime victim of nuclear radiation, although there had been at least three previous deaths caused by radiation. The experiment which cost Slotin his life is still done, except now it is done by remote control where the operator is a quarter of a mile away from the fissionable material.

Three of Slotin's colleagues wrote, "His death, like his life, was quiet, brave, and clear."

MECH MISS

Elaine Pascal

The AIEE-IRE was quite proud of itself when it spotted Elaine Pascal on GW's campus. It turned out, however, that this was not the first organization to discover the many charms of this month's lovely Mech Miss. At UCLA, where Elaine spent her freshman year, she was choosen IFC Alumni Queen of Southern California and Queen of the Southern Campus, the UCLA yearbook. She was also Miss Miami Beach of 1960.

Elaine, a 20 year old sophomore, is majoring in political science. Carrying her interest in politics beyond the classroom she attended the last Democratic National Convention, doing publicity work for the State of Florida. Although Elaine has done a lot of traveling, she plans to settle down for the next two years so that she can graduate from George Washington. Next year she hopes to be taking part in some of the University drama productions.

As for future plans, Elaine's ambition is to work in international corporate law. That would make some combination with engineering. What about it fellows?

TECH NEWS

Edited by Larry C. Hice

NO MORE TRAFFIC SNARLS

An advanced transportation concept designed to smooth rush hour traffic and provide economical service was displayed in Baltimore, Maryland. The new plan is called the Carveyor concept and was developed jointly by the Goodyear Tire and Rubber Company and the Stephens-Adamson Manufacturing Co. of Aurora, Illinois.

In the system, pedestrians move on conveyor belts. Passengers are seated in cars with capacities from four to ten persons and are moved over a conveyor belt at a speed of fifteen miles per hour. Operation is non-stop on an elevated or subway basis; consequently, the cars outdistance normal surface traffic. At boarding and exit points, the cars are slowed down on carefully timed rollers to about half the normal walking speed. They are paralleled by moving sidewalks for entry and exit at these points. Therefore, the passenger need not worry about stepping off a moving surface to a stationary one.

This system would provide immediate service to passengers, thus avoiding crowds at bus or subway terminals. People would not have to wait because there would be a continuous flow of cars at the stations.

Sections of New York City and Atlanta, Georgia, are already considering the use of the Carveyor system. The system was displayed in Baltimore so that the citizen groups who will be studying transportation problems could consider the advanced concept.

CONDUCTIVE FLOORING FOR HOSPITAL

Conductive flooring is as serviceable as nonconductive flooring of the same type, and it prevents sparks forming in such areas as hospital operating rooms where explosive vapors are often found. Current methods are satisfactory for measuring the resistance of conductive flooring.

PARTICLE ACCELERATOR

SAMES of New York City has announced the production of a new 600 KV model S particle accelerator for use in basic research and applications in nuclear physics, chemistry, medicine, and commercial and industrial processes. This particle accelerator offers a highly stable continuous DC output from zero to 600 KV providing for infinite adjustment. It is capable of producing a wide range of particles and radiations (electrons, protons, neutrons, deuterons, X-rays, etc.).

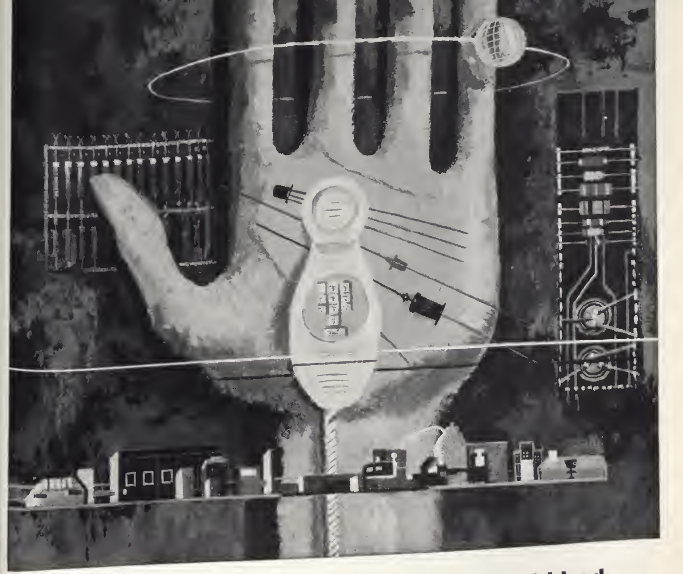
The new particle accelerator contains a four lens accelerator tube and an auxiliary power unit whose voltage can be adjusted from a control console. The potential of the focusing electrode is supplied by the auxiliary unit. A resistance divider provides other electrode potentials. The high frequency ion source is supplied by an alternator which is operated from a remote control desk.

When operating at full power, the unit has a rated power consumption of ten KVA. The accelerator can be equipped with either a medium or high stability generator. The high voltage generator has a maximum voltage of 600 KV.

600 KV Model S Particle Accelerator

MAGNESIUM BATS

Major league batters soon may be swinging with a piece of magnesium instead of ash, reports American Machinist/Metalworking Manufacturing. Bats made of magnesium with a plastic covering are said to be as good as wood, and the sting following a hit is eliminated.



Our future is in the hands of men not yet hired

At Western Electric we play a vital role in helping meet the complex needs of America's vast communications networks. And a career at Western Electric, the manufacturing arm of the nation-wide Bell Telephone System, offers young men the exciting opportunity to help us meet these important needs.

Today, Western Electric equipment reduces thousands of miles to fractions of seconds. Even so, we know that our present communications systems will be inadequate tomorrow; and we are seeking ways to keep up with — and anticipate — the future. For instance, right now Western Electric engineers are working on various phases of solar cell manufacture, miniaturization, data transmission, futuristic telephones, electronic central offices, and computer-controlled production lines — to name just a few.

To perfect the work now in progress and launch many new communications products, projects, procedures, and processes not yet in the mind of man — we need quality-minded engineers. If you feel that you can meet our standards, consider the opportunities offered by working with our company. In a few short years, *you* will *be* Western Electric.

Challenging opportunities exist now at Western Electric for electrical, mechanical, industrial, and chemical engineers, as well as physical science, liberal arts, and business majors. All qualified applicants will receive careful consideration for employment without regard to race, creed, color or national origin. *For more information about Western Electric,* write College Relations, Western Electric Company, Room 6205, 222 Broadway, New York 38, New York. And be sure to arrange for a Western Electric interview when our college representatives visit your campus.

Western Electric

MANUFACTURING AND SUPPLY — BELL SYSTEM — UNIT OF THE BELL SYSTEM

Principal manufacturing locations at Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Omaha, Neb.; Kansas City, Mo.; Columbus, Ohio; Oklahoma City, Okla. Engineering Research Center, Princeton, N. J. Teletype Corporation, Skokie, Ill., and Little Rock, Ark. Also Western Electric distribution centers in 33 cities and installation headquarters in 16 cities. General headquarters: 195 Broadway, New York 7, N. Y.

CAMPUS NEWS

ASME

At the April 4 meeting of ASME, the following officers were elected:

Chairman	Douglas Jones
Vice Chairman	Richard Singer
E. C. Representative	Robert Alvarez
Program Chairman	Jerry Edwards

It was decided to defer the election of Secretary and Treasurer until the May meeting.

After the election the ME's were joined by the CE's to hear a talk by Mr. Earl Angulo of NASA's Goddard Space Flight Center. Mr. Angulo gave a very interesting talk on the Explorer X Space Probe complete with slides and a film of the launching.

Professor Dedrick; along with Arthur Macurdy, Robert Alvarez, Arthur Howard, Marshall Levitan and Douglas Jones; represented the GWU section at the regional student paper contest at Lehigh University. Art Macurdy gave a talk on a Hydraulic Shaft Isolator for a Nuclear Submarine that was good enough to win fifth prize. Congratulations Arthur!!

ASCE

On April 14 the CE's participated in a regional conclave attended by Johns Hopkins, Catholic, Maryland, and Howard Universities. They traveled by bus to the Dulles International Airport for morning meetings and a tour of the airport in the afternoon. One of the centers of attraction was the enormous mobile lounge for transporting passengers to the planes. The lounge had a capacity of about 75 people and was so large that it had to be brought to the airport in sections. Another feature was the engineering design of the main terminal building. It was made from concrete in a saucer shaped form that permitted it to use no supporting pillars.

AIEE-IRE

In the May meeting the EE's, Dr. Samuel Seeley spoke on the Half-life of the Engineering Curriculum.

THETA TAU

Election results:

Regent	Richard Singer
Vice Regent	Douglas Jones
Scribe	Clifford Stearns
Treasurer	Eliot Cohen
Corres. Sec.	Jerry Steffel
E. C. Rep.	Harvey Flatt

And a good time was had by all! (hic)

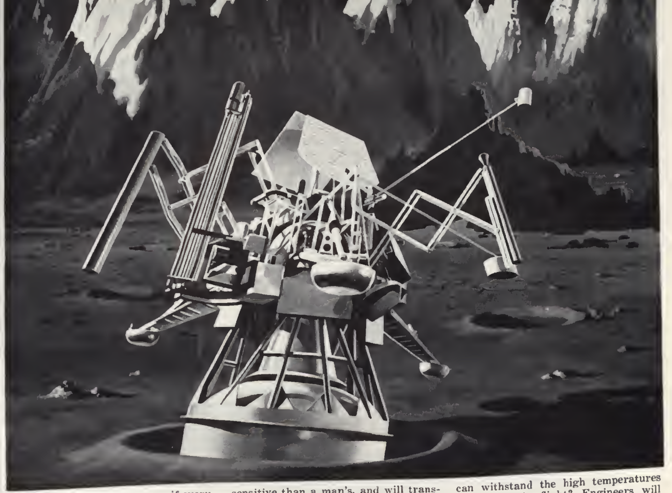
SIGMA TAU

Sigma Tau held its Spring Initiation Banquet and Ball to honor its new members. Those selected for membership were Carlos Alonso, Ivan Kavrukov, Marshall Levitan, Joong Lee, Donald Lokerson, Bob McCalley, Agit Ratra, Stephen Rich, and Marvin Spivak. The Banquet and Ball was held at Tom Sarris' Steak House and it was enjoyed by all who attended.

SIGMA EPSILON

Elections were held in this society, also.

President	Erling Jacobsen
Vice Pres.	Frank Klish
Secretary-Treasurer	Donald Eddins
Faculty Advisers	Profs. Ojalvo, Fox, Ferris, and Dedrick.



Moon crawler. Early next year, if everything goes according to plan, this spiderlike object — the "Surveyor" — is expected to land on the moon's surface, look at it, feel it, and bite into it. It will have electronic sight and touch more sensitive than a man's, and will transmit to earth direct information on what the moon looks like and what it is made of. What metal will this machine need to survive the moon's extreme cold without getting brittle? What metal can withstand the high temperatures that occur in flight? Engineers will most likely find the answer in Nickel-containing alloys. They offer tremendous resistance to crippling super-cold, stand up in blazing heat.

How Inco Nickel helps engineers make new designs possible and practical

Gyron—dream car that drives itself. A gyroscope would stabilize this two-wheeled vehicle of the future, which envisions automatic speed and steering control. A computer would let you "program" trips on a non-stop highway. For lasting beauty, trim areas would be coated with Nickel-Chrome plating, the bright, corrosion-resistant finish.

Hydrofoil ship—a new concept in seagoing design. Now under development, such vessels are planned to travel 100 m.p.h., skim over the tops of waves like flying fish—lifted aloft by a set of underwater foils, or wings. The metal for these all-important wings? Good bet is a nickel alloy for strength, resistance to corrosion and cavitation erosion.

Whatever his area of exploration, today's engineer knows that Nickel-containing metals can make many new designs perform better. For complex components of a moon surveyor, or the decorative plating of a gyroscopic car, Nickel, or one of its alloys, meets the demands of a wide range of service conditions—makes an excellent choice for products we use today, and for tomorrow's new designs.

You'll find Inco's List "A" helpful and informative. It has descriptions of 200 publications, covering applications and properties of Nickel and its alloys. Write: Educational Services,

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

INCO **INTERNATIONAL NICKEL**

The International Nickel Company, Inc., is the U.S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada) —producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium, Sulfur and Platinum, Palladium and Other Precious Metals.

CIVIL ENGINEERS:

Prepare for your future in highway engineering—get the facts about new DEEP-STRENGTH (Asphalt-Base) pavement

With today's "giant step forward" in pavement engineering—DEEP-STRENGTH (Asphalt-Base) pavement—there is need for engineers with a solid background in the fundamentals of Asphalt technology and pavement construction.

Because new DEEP-STRENGTH Asphalt-base construction provides the most durable, most economical pavement modern engineering science has developed, Interstate and primary superhighways in all parts of the country are being built with advanced design DEEP-STRENGTH Asphalt pavement.

Already, more than 90% of America's paved roads and streets are surfaced with Asphalt. And Asphalt pavements have successfully kept America's wheels rolling since 1876.

Your contribution—and reward—in our nation's vast road-building program can depend on **your** knowledge of modern Asphalt technology. So, prepare for your future **now**. Write for your free "Student Kit" about Asphalt technology.

The Asphalt Institute
College Park,
Maryland

A PERFECT IDEA

There was an old man who had a shop in his house
And in there too was also his spouse.

Now the warmth of the shop brought mice from afar,
and kept the number of rats up to par.

Since the presence of rodents brought bad name to the shop,
our friend wanted to bring their activities to a stop.

So he closed all the windows and sealed up the door.
The exhaust of his auto he brought in through the floor.

A perfect idea from the soundest of thinking.
The engine he started without even blinking.

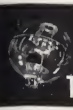
The gas filled the room and killed all the rats,
but unknown gremlins had planned certain facts.

For in through leaky sections of the wall
Deadly fingers of the fumes could crawl.

And into the kitchen the gas made its way
and in its cruel manner took his wife away.

Our friend mourned his loss, but he had learned too late
that no matter how perfect an idea man can make
those mean little gremlins will always get their take.

W. M. YATER



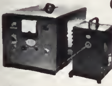
ADVANCED FLASH TECHNOLOGY

for

- Flash-induced chemical catalysis
- High-speed photography of chemical and process reaction
- Motion studies, shock-wave photos
- Cloud chamber physics
- Deep-sea photography
- U.V. printing and time-marking
- Satellite beacon systems

EG&G's leadership in flash technology is solidly based on original contributions to the state of the art which have produced more than 40 patents for tubes, circuits and strobe systems.

OPTICAL MASER (LASER) LIGHT PUMPS



531 532

400 ws. system $1190

1280 ws. system $3345

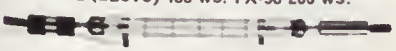
Model 531 Output: 400 ws. (1050 mfd at 900 v.) Input: 115 v. 60 cycle a.c. Price $795. Model 532 Flash Head with 2 Model 100 tubes: $395. System will drive ruby rods with 400 ws. threshold. System price: $1190.

Model 522 Two unit 1280 ws. system provides up to 4 kv. into 80 mfd. or 160 mfd. Triggered externally or from front panel. Drives Model 511, 512, 513 Flash Heads with 4 to 10 Model 100 tubes. Accommodates crystals 2" long up to ½" dia. Input: 110 v. or 220 v. 60 cycle ac. Price $3345 (complete system with 4 tubes).

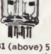
Note: Power supplies, capacitor banks, flash heads, pulse transformers are all available as separate items.

XENON FLASH TUBES

FX-1 (above) 400 ws. FX-38 200 ws.



FX-42 (above) 3" arc, 600 ws.
FX-45 6" arc, 2000 ws.



Model 100

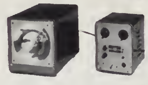
FX-31 (above) 5 ws. flat-topped for optimum optical characteristics.

Further information on request on above products and on Hydrogen Thyratrons and Diodes, Triggered Spark Gaps, Transformers, Oceanographic Instruments, Radiation Detection Devices, other Flash Tubes, Flash Machines, Stroboscopes, etc.

Edgerton, Germeshausen & Grier, Inc.

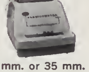
180 BROOKLINE AVENUE, BOSTON 15, MASS.

ELECTRONIC FLASH EQUIPMENT



Microflash Flash Duration: 0.5 microsecond. Peak Light: 50 x 10^6 beam candle power. Energy Input: 8 ws (.05 mfd at 18 kv). Recycle Time: 5 seconds. Time Delay: Adjustable from 3 to 1000 microseconds. Price: $975.00. Point Light Source Attachment: $35.00.

MARK VI SENSITOMETER

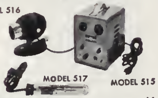


Compact, easy to use, laboratory device. Will accommodate glass plates, 16 mm. or 35 mm. films. Exposure Times: 1/100, 1/1000, 1/10,000 second. Built-in voltage regulator. Color correction filters unnecessary. Price $600.00. Mark VII Sensitometer, which has the additional ranges of 1/100,000 and 1/1,000,000, is available at $1200.00.

High-Speed STROBOSCOPE

Light source specially developed for use with high-speed cameras for studies of fast-moving objects such as shock waves and projectiles. Flashing Rate: Up to 6000 flashes per second. Flash Duration: As low as 1.2 microsecond. Triggering: From camera, oscillator or contactor. Price: $3500.00.

MODEL 516



MODEL 517 MODEL 515

Microscope Flash Illuminator Model 516 lamp and 515 power supply provides high intensity flashes (150 microseconds at 100 ws) for extreme close-up photography of delicate subjects without heat damage . . . e.g. human eye, insects, botanical specimens, etc. Model 517, separate lamp assembly permits close-ups of underwater subjects in fish tanks, etc. Complete system, consisting of models 515, 516 and 517 — $579.00.

Double Flash for silhouette photography . . . flashes at accurately timed intervals from 5 to 100 microseconds. Flash duration ⅓ microsecond. Price: $2000.00

Multiple Microflash for superimposition of up to 20 photographs on single negative at up to 100 kc. rate. Price: Basic unit: $2800.00. Discharge units: $525.00 ea.

TEL. COPLEY 7-9700
CABLE: EGGINC, BOSTON; TWX: BS 1099
Edgerton, Germeshausen & Grier
180 BROOKLINE AVE., BOSTON 15, MASS.

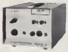
milli-mike® INSTRUMENTS

EG&G's milli-mike instruments were the first and are, by a substantial margin, the most advanced in the field of submillimicrosecond recording and measurement.

MODEL 707 OSCILLOSCOPE

DC to 2000 Mc bandwidth . . . 0.2 millimicrosecond rise time . . . single transient and repetitive signal capability . . . sensibility: 55 mv/trace width. Small spot size, maximum resolution. Six calibrated sweep speeds: 5, 30, 100, 300, 1000 and 3000 milli-microseconds/cm. Easy to operate invaluable for measurement of diode recovery time, ultra-high-frequency phenomena and in many other applications.

MODEL 751 PULSE GENERATOR



All solid-state, transistorized, high-speed pulse generator produces positive pulses of fast rise time (less than 1 millimicrosecond). Repetition rate: 10 cycles to 100 kc. Output pulse width: 2 to 100 millimicroseconds. Pulse amplitude: 20 v. into 50 ohms approx. Operable in any position. Price: $285.

MODEL 850 CAMERA SYSTEM

Optimized, fully integrated system for photographic recording of the fastest transients at 1:1 magnification.

DIODE RECOVERY CABLE SYSTEM

Model 760, a complete system for accurate observation and measurement of diode recovery time in the millimicrosecond region. Controls and meter on front panel of sturdy metal case.

PULSE INVERTERS

Model TR-6 — coaxial-ferrite balun with excellent frequency response for converting 50 ohm single-ended to push-pull 100 ohm signals. Model 819 (for use with EG&G Model 751 Pulse Generator) to provide negative pulse output.

RADIATION MEASUREMENTS

Complete systems using EG&G detectors and Model 707 Scope . . . available for measurement of high-frequency pulsed radiation.

TRANSFORMERS, POWER SUPPLIES

EG&G is outstandingly well staffed and equipped to design and produce custom-built transformers, chokes, magnetic amplifiers, DC to DC converters, pulse transformers and power supplies for military or commercial use . . . and trigger transformers for all types of flash tubes.

Full technical information on all products available on request.

Edgerton, Germeshausen & Grier, Inc.

180 BROOKLINE AVENUE, BOSTON 15, MASS.

My cousin who is in the Boy Scouts just sent me a lovely snakeskin belt he made himself. There's only one trouble, the snake is still alive. Of course, I have the only belt that can buckel itself. But every time Sherman (that's the snake's name) yawns, my pants fall down.

In school I used to write the answers to exams on my sleeve. My shirt graduated two years before I did.

Math Prof: Now, if I subtract 25 from 37 what's the difference?
Freshman: Yeah! That's what I say. Who cares?

And then there was the butcher who backed into a meat grinder and got a little behind in his orders.

With queenly grace she floated along the street, but at the curb she paused and her little pink brow furrowed as she gazed at the river of mud before her. Our hero, seeing her plight, rushed to her side and tearing off his topcoat, spread it in the mud so that she might not soil her lovely slippers. She gazed at him in wonder for a moment, then murmured softly, "Well, of all the damn fools."

"Light house no good for flog," says Chinaman. "Lighthouse he shine. Whistle he blow, flog bell he ring, and flog he come just the same. No glood."

Proverbs

A pebble, in a state of circumvolution, acquires no lichens.
Feathered bipeds of similar plumage will live gregariously.
Why should the smaller domestic utensils accuse the larger of nigritude.
Too great a number of culinary assistants may impair the flavour of the consomme.
The capital of the papal state was not constructed in a diurnal revolution of the globe.

I shot an arrow into the air.
It fell to earth, I know not where;
I lost ten of the damned things that way.

"How did you get that black eye?"
"It's a berth mark."
"What do you mean, birth mark?"
"I got in the wrong one last night."

I stole a kiss the other night.
My conscience hurts, alack.
I guess I'll go tomorrow night
And put the dern thing back!

In a shack on Wake Island four Marines were playing bridge when another leatherneck rushed in shouting, "Two hundred Japs have landed on the beach."
The four marines looked from one to the other, and finally one said, "I'll go -- I'm dummy this hand."

Landlady: "A professor formerly occupied this room. He invented an explosive."
New Roomer: "I see, I suppose those spots on the ceiling are the explosive?"
Landlady: "No, they're the professor."

Robert Welch is now represented among the campus youth movements. The new group is called "The Sons of Birches."

One should not become over confident in the knowledge of science. An interstate trucker stopped for an attractive miss standing at the side of the highway.
"You are taking a big chance," she said. "After all, I might be a wicked witch in disguise."
He only laughed, but, sure enough, he soon turned into a motel.

"So you want to be a lifeguard here, eh? How tall are you?"
"Six feet, eight inches, sir."
"Can you swim?"
"No, but I can wade to beat hell."

House Mother: "Are you entertaining a man in your room?"
Flora: "Just a minute, I'll ask him."

Date: "You remind me of the ocean."
E. E.: "You mean I'm wild, romantic, and restless?"
Date: "No, you make me sick."

People who live in glass houses might as well; everybody knows they do.

Looking coldly at the man who had just given him a nickle for carrying his bag twelve blocks, the little boy said, "You know, mister, I know something about you."
"What?" asked the man.
"You're a bachelor."
"That's right. Do you know anything else about me?"
"So was your father."

Know what becomes of doughnut holes after the doughnuts are eaten....
IBM makes a fortune cutting them up in little pieces and pasting them on cards.

Connect 20,000 volts across a pint. If the current jumps it, the product is poor. If the current causes a precipitation of lye, tin, arsenic, iron, slag, or alum, the whiskey is fair. If the liquor chases the current back into the generator, you've got good whiskey.

DRAFTSMEN'S SUPPLIES
MUTH
1332 N.Y. Ave. N.W. ST. 3-6323
TRY MUTH FIRST

Kodak beyond the snapshot...
(random notes)

Densitometry in Lilliput

Photography is art, photography is amusement, and more and more photography is a way of packing information and electronic circuitry. The packing calls for thinking very, very small about photography.

We cannot be blamed for feeling a little wistful as we cheer photography's progress in Lilliput. A remarkably small number of dollars worth of KODAK High-Resolution Plates and KODAK KPR Photo Resist are used up in producing a remarkably large number of solid-state microcircuits.

Fear not for us. We'll make out.

Nowhere will you catch us claiming that this "micro" business is as easy as falling off a log. Indeed, an appreciation of the relationship between the logs of exposure and reciprocal transmittance makes scarcely more than a good beginning toward controlling them on a micro scale. Here the frequency response of a photographic emulsion must be cascaded with the frequency response of the other components in the total picture-handling system.

The game is widely believed to be worth the candle. To shed light on what is really going on, one needs to be able to measure density reliably over an area less than ½ micron wide, scanned in synchronism with a recorder that responds logarithmically.

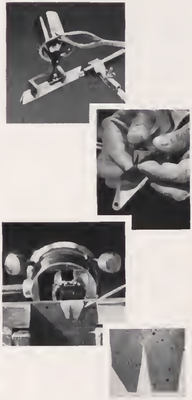
Not only do we use such instruments, but we build them and sell them for money to others. This benefits science and cheers us up.

Faithful but flexible

We find the trick shown below helpful in microscopic studies of profile sections along objects like knives. The casting material is our *Epolene C-10* Polyethylene Resin. You pour it at only 100°C. Yet at room temperature the little casting "remembers" its shape so accurately that despite the twist of unpeeling, profile details as small as 0.00009-in. radius are preserved in the sliced sections, and measurements are repeatable to ±0.00001". Then, if overheating is avoided, you can remelt and reuse the resin for more castings.

The man who came up with this trick is on our payroll to ward off trouble from micro-organisms in making film and paper. He is a microbiologist and has never been asked to contribute to machine shop practice in order to impress the plastics-molding trade.

Life can be devious instead of tedious.



It projects slides!

Learned and scientific as we are, we have not lost interest in simple consumer goods.

If you really want to know the truth, consumers are enjoying a simplicity kick at present. We even suspect you of being the type yourself. Otherwise we wouldn't be advertising the KODAK READYMATIC 500 Slide Projector to you.

It doesn't just scream "latest design!" but quietly is.

If you buy like that, you will pay less than $70 for a 500-watt 2x2 projector, complete with case and 4-inch lens, while sacrificing neither optical performance nor ease of slide-changing nor ruggedness of construction.

If you engineer like that, you will have a prosperous career with a manufacturing organization that values its reputation.

GOOD PACKING NEEDS GOOD RESEARCH

GOOD BUYS NEED GOOD ENGINEERING

From edible lubricants to erasable copying films, plenty of lively careers to be made with Kodak in research, engineering, production, marketing.

And whether you work for us or not, photography in some form will probably have a part in your work as years go on. Now or later, feel free to ask for Kodak literature or help on anything photographic.

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

Price subject to change without notice.

Kodak
TRADEMARK

An interview with General Electric's W. Scott Hill

Manager—Engineering Recruiting

One of a series . . .

How to Make the Most of Your First Five Years

MR. HILL has managerial responsibility for General Electric's college recruiting activities for engineers, scientists, PhD's and technicians for the engineering function of the Company. Long active in technical personnel development within General Electric, he also serves as vice president of the Engineers' Council for Professional Development, board member of the Engineering Manpower Commission, director of the Engineering Societies Personnel Service and as an officer or member of a variety of technical societies.

Q. Mr. Hill, I've heard that my first five years in industry may be the most critical of my career. Do you agree?

A. Definitely. It is during this stage that you'll be sharpening your career objectives, broadening your knowledge and experience, finding your place in professional practice and developing work and study habits that you may follow throughout your career. It's a period fraught with challenge and opportunity—and possible pitfalls.

Recognizing the importance of this period, the Engineers' Council for Professional Development has published an excellent kit of material for young engineers. It is titled "Your First 5 Years." I would strongly recommend you obtain a copy.*

Q. What can I do to make best use of these important years?

A. First of all, be sure that the company you join provides ample opportunity for professional development during this critical phase of your career.

Then, develop a planned, organized personal development program—tailored to your own strengths, weaknesses and aspirations—to make the most of these opportunities. This, of course, calls for a critical self appraisal, and periodic reappraisals. You will find an extremely useful guide for this purpose in the "First 5 Years" kit I just mentioned.

Q. How does General Electric encourage self development during this period?

A. In many ways. Because we recognize professional self-development as a never-ending process, we encourage technical employees to continue their education not only during their early years but throughout their careers.

We do this through a variety of programs and incentives. General Electric's Tuition Refund Program, for example, provides up to 100% reimbursement for tuition and fees incurred for graduate study. Another enables the selected graduate with proper qualifications to obtain a master's degree, tuition free, while earning up to 75% of his full-time salary. These programs are supplemented by a wide range of technical and nontechnical in-plant courses conducted at the graduate level by recognized Company experts.

Frequent personal appraisals and encouragement for participation in professional societies are still other ways in which G.E. assists professional employees to develop their full potential.

Q. What about training programs? Just how valuable are they to the young engineer?

A. Quite valuable, generally. But there are exceptions. Many seniors and graduate students, for example, already have clearly defined career goals and professional interests and demonstrated abilities in a specific field. In such cases, direct placement in a specific position may be the better alternative.

Training programs, on the other hand, provide the opportunity to gain valuable on-the-job experience in several fields while broadening your base of knowledge through related course study. This kind of training enables you to bring your career objectives into sharp focus and provides a solid foundation for your development, whether your interests tend toward specialization or management. This is particularly true in a highly diversified company like General Electric where young technical graduates are exposed to many facets of engineering and to a variety of product areas.

Q. What types of training programs does your company offer, Mr. Hill?

A. General Electric conducts a number of them. Those attracting the majority of technical graduates are the Engineering and Science, Technical Marketing and Manufacturing Training Programs. Each includes on-the-job experience on full-time rotating assignments supplemented by a formal study curriculum.

Q. You mentioned professional societies. Do you feel there is any advantage in joining early in your career?

A. I do indeed. In fact, I would recommend you join a student chapter on your campus now if you haven't already done so.

Professional societies offer the young engineer many opportunities to expand his fund of knowledge through association with leaders in his profession, to gain recognition in his field, and to make a real contribution to his profession. Because General Electric benefits directly, the Company often helps defray expenses incurred by professional employees engaged in the activities of these organizations.

Q. Is there anything I can do now to better prepare myself for the transition from college campus to industry?

A. There are many things, naturally, most of which you are already doing in the course of your education.

But there is one important area you may be overlooking. I would suggest you recognize now that your job—whatever it is—is going to be made easier by the ability to communicate . . . effectively. Learn to sell yourself and your ideas. Our own experience at General Electric—and industry-wide surveys as well—indicates that the lack of this ability can be one of the major shortcomings of young technical graduates.

**The kit "Your First 5 Years," published by the Engineers' Council for Professional Development, normally sells for $2.00. While our limited supply lasts, however, you may obtain a copy by simply writing General Electric Company, Section 699-04, Schenectady, New York.*

(An equal opportunity employer.)

Progress Is Our Most Important Product

GENERAL ELECTRIC